RESEARCH HIGHLIGHT

October 2010

Technical Series 10-101

Don River Watershed Site Evaluation—Predicting Effectiveness of Stormwater Source Controls in Urban Watershed Revitalization

INTRODUCTION

The Don River flows through the heart of the Greater Toronto Area. From its headwaters on the Oak Ridges Moraine to its mouth in the heart of Toronto's industrial waterfront, the watershed is over 80 per cent urbanized. Fifteen years ago Toronto and Region Conservation and the Don Watershed Task Force released *Forty Steps to a New Don*, a call to action to restore this troubled river system. Since then, countless volunteers and agency staff have worked to implement that vision of a revitalized Don River.

In 2006, Toronto and Region Conservation began the process of updating the science on this watershed and developing a new *Don River Watershed Plan* for the next phase in its restoration. The need for innovative stormwater management practices emerged as a key component of the recommendations from the new Don plan. Much of the watershed is already built up so the emphasis is on retrofitting existing communities with enhanced stormwater management. Stormwater source controls (also called low impact development measures) such as permeable pavement, bioswales, rain gardens, rainwater harvesting and downspout disconnection are recommended for private and public lands. As space and capital dollars for stormwater work are limited, creative solutions that achieve multiple objectives and integrate well with existing communities are needed.

To illustrate possible scenarios for implementing the watershed plan's recommendations at a local scale, five concept site plans were developed. The sites were chosen to be representative of common challenges faced in many locations throughout the watershed. The plans illustrated a suite of actions that could be implemented to achieve gains in water quality, water balance, erosion control, natural heritage protection and community engagement within the context of other sustainability elements. Three of the five site plans proposed significant stormwater source control activities.

As a part of a broader research initiative to support the development of a hydrologic modelling tool, CMHC provided research funding to apply the hydrologic model to the three sites to assess the outcomes of different residential developments and other measures on stormwater and how innovative practices can mitigate adverse environmental impacts of stormwater. The hydrologic modelling was used to estimate the potential reductions in peak flows (and associated flood risk and erosion potential) and overall flow volume that might result from implementing these measures.

HYDROLOGIC MODELLING METHODOLOGY

Three scenarios were modelled at each site:

- pre-development agricultural conditions;
- existing urban conditions;
- proposed conditions with the stormwater source control measures outlined in the concept site plans.

The analysis for each site was completed using the hydrologic modelling software Visual OTTHYMO version 2.0. Modifications were made to the model input values for each scenario based on the different land use and stormwater source control assumptions. Each of the three scenarios was run at a variety of storm intensities. The smallest storm event was five millimetres, a rainfall event that is very common in southern Ontario.

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The modelling was also completed for 25 mm, two-year, five-year, 10-year, 25-year, 50-year and 100-year return period storm events. The following sections describe the features of each concept site plan and the hydrologic model findings.

CONCEPT SITE 1

Building Sustainable Neighbourhoods – Warden Woods Residential Area, Toronto

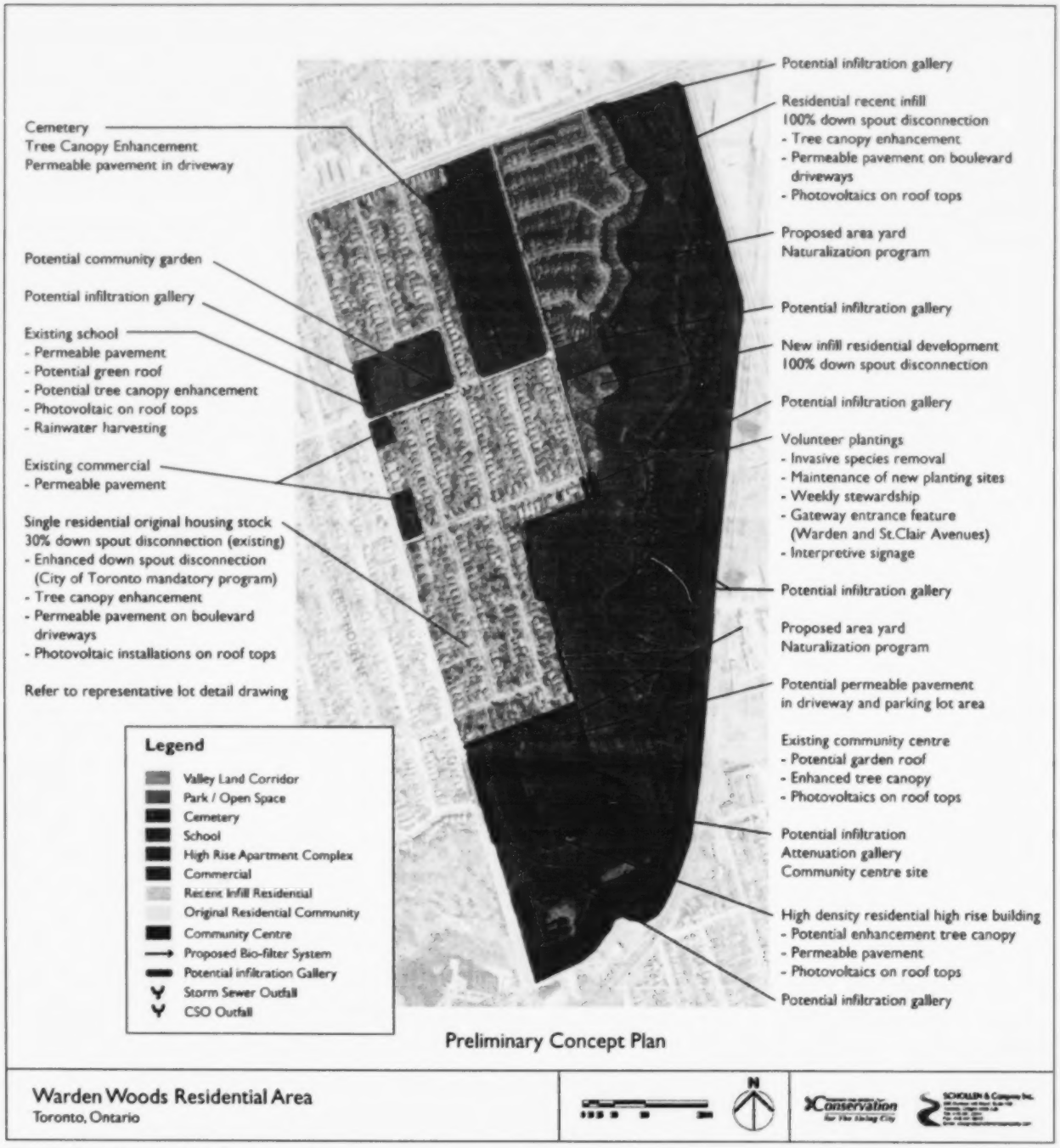


Figure 1 Warden Woods Concept Plan

Concept Site Features

The 1950s suburban single family housing that covers much of the Warden Woods area is typical of many older residential areas throughout the watershed. The concept site plan showcases how such older housing stock can be made more sustainable by improving energy efficiency and water conservation, and implementing other green retrofits.

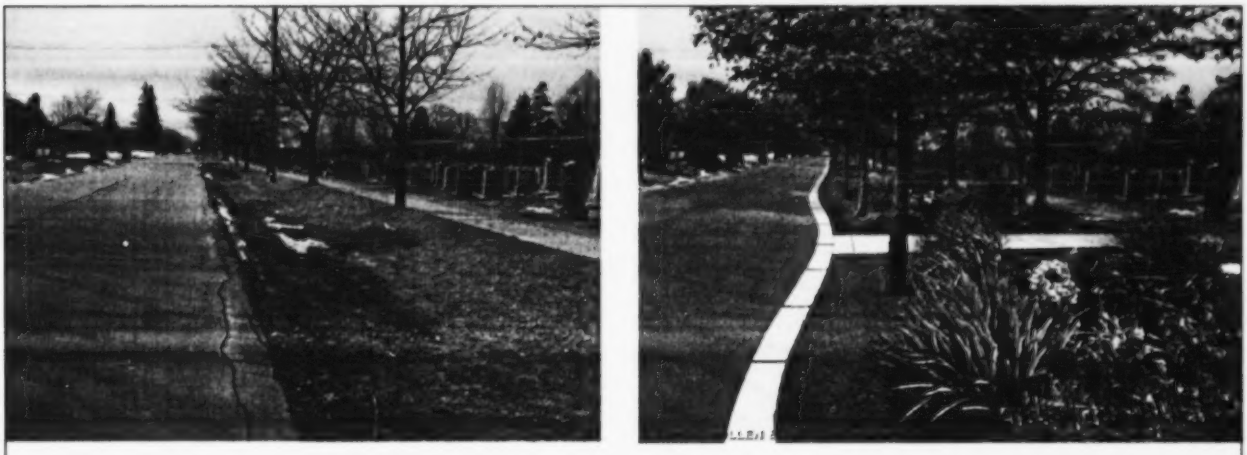
Diverting stormwater from the combined sewer system will also reduce overflows into Taylor/Massey Creek, mitigate erosion and improve downstream water quality. Under the site plan, improved stormwater management and water infiltration/attenuation techniques would be implemented. The valley parks and other natural areas would be protected and regenerated to restore ecosystem functionality and improve community enjoyment. In addition to promoting a more sustainable community, the site plan would: restore vegetation and enhance the tree canopy; mitigate the urban heat island effect; enhance public awareness of environmental/conservation practices; and improve the streetscape and pedestrian realms.

Modelling Results

The stormwater management components in the 'proposed conditions' scenario for Warden Woods reduced peak flows and flow volume for both the smaller storm events and the larger, less common storms in the modelling.

For the most frequent category of storms (resulting in 5-25 mm of precipitation), peak flows were reduced 40-45% and runoff volume is decreased by about 20-45%. This decrease in runoff would help to reduce many of the erosion and water quality concerns in this section of Taylor/Massey Creek.

Peak flows from larger storm events (i.e., those that would occur in the 5-100 year timeframe) would also be reduced by 20-35%. The concept site plan would improve the resiliency of the system and help mitigate the impacts of these events.



Existing: The right-of-way bordering the Dawes Road Cemetery. Note, the roadside swale which enhances the potential for stormwater infiltration.

Prospective: A more attractive, pedestrian friendly streetscape. Additional native trees have been planted. Low-maintenance "rain gardens" are designed to encourage water infiltration. A new, more efficient biofilter system has replaced the swale.

Figure 2 Transforming a 1950s Suburban Community

CONCEPT SITE 2

Ravine Challenges – Mud Creek, Toronto

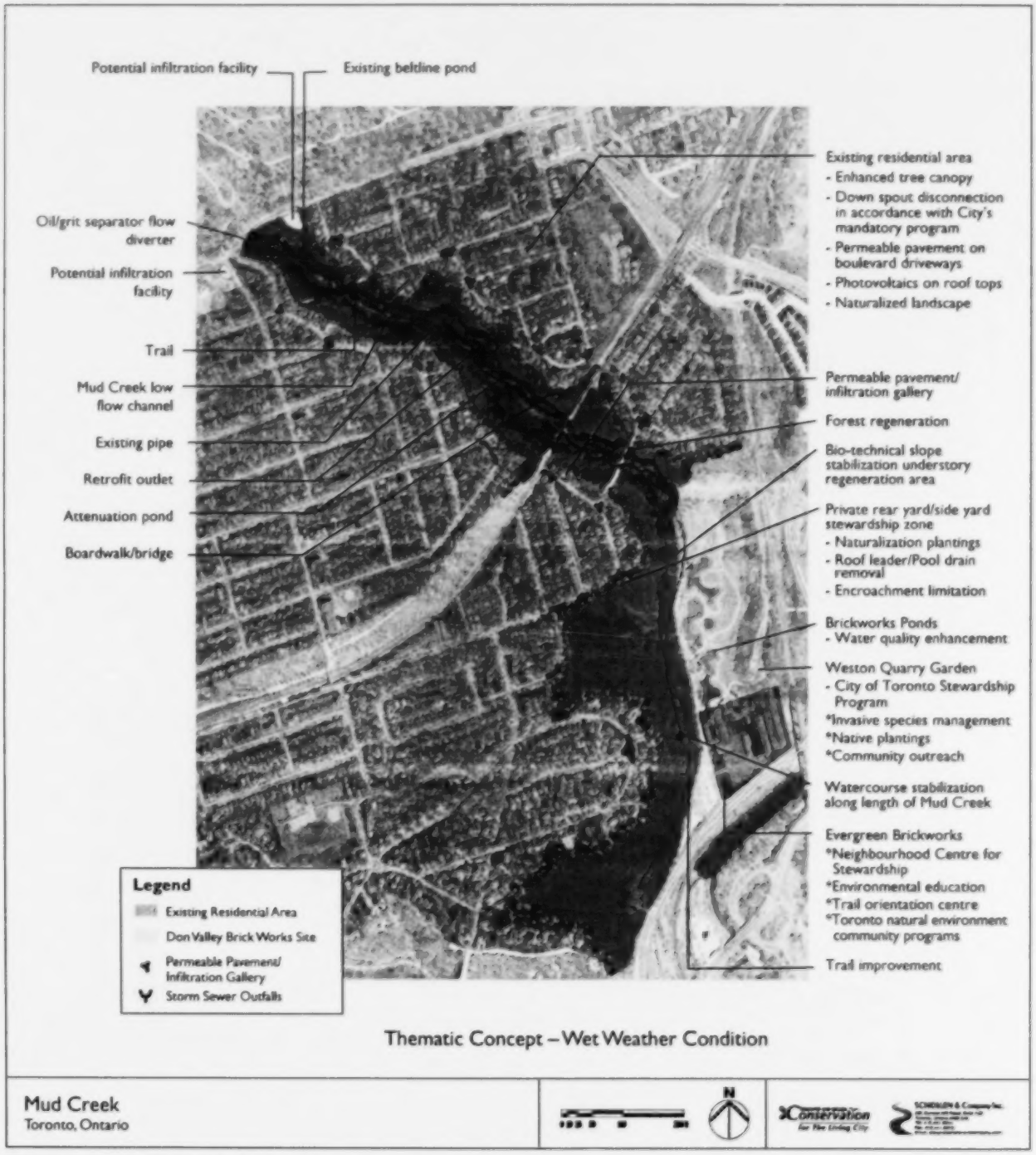


Figure 3 Concept Plan for Mud Creek

Concept Site Features

The erosion problems evident in Mud Creek are typical of those seen in many other ravines throughout the lower part of the watershed. The contributing causes are ineffective stormwater control, heavy pedestrian traffic on formal and informal trails and the actions of neighbouring homeowners. This concept site highlights community stewardship initiatives to manage stormwater at the lot level on neighbouring properties and eliminate encroachment. Suggested actions include: infiltration galleries, bioswales, permeable pavement on driveways, downspout disconnection and green roof technology.

The concept site plan also addresses wet weather flow control by creating a series of flow regulating structures and water holding ponds (attenuation areas) upstream of each piped segment of the creek. In addition, a new surface baseflow channel would be created along the entire length of the ravine. The currently deteriorating gabions along the exposed stream banks would be replaced with biotechnical stabilization works such as stone in-laid with vegetation, and the failed grade control structures near the Don Valley Brick Works site would be replaced and upgraded. A number of additional initiatives would be undertaken to increase the ravine's biodiversity, improve the trail system, protect at-risk environmental components, and expand public outreach through interpretive signage.

Modelling Results

The 'proposed conditions' scenario for the Mud Creek site plan modelled the potential effects of the source control measures on the tablelands on peak flow and flow volume. Results showed reductions in peak flows (22-52%) and flow volume (6-53%) from the existing conditions. The greatest reductions in both peak flows and flow volume are seen in the smallest storm events. This supports the case for implementing these measures as the smaller (<20mm) storms are the most common type of event in this area and have a significant cumulative impact on erosion in the creek.

Existing: the trail traveling north towards the Governors Road bridge. The hard-packed trail has encroached into the surrounding forest and a number of dead limbs and fallen trunks pose a threat to trail users.

Prospective: The trail has been narrowed, surfaced and repositioned alongside the new surface channel which carries the baseflow of Mud Creek. The channel banks are protected by stone interspersed with native vegetative plantings.

Figure 4 Transforming a Buried Creek

CONCEPT SITE 3 –

A Sustainability Makeover: Generic Commercial/Industrial Example

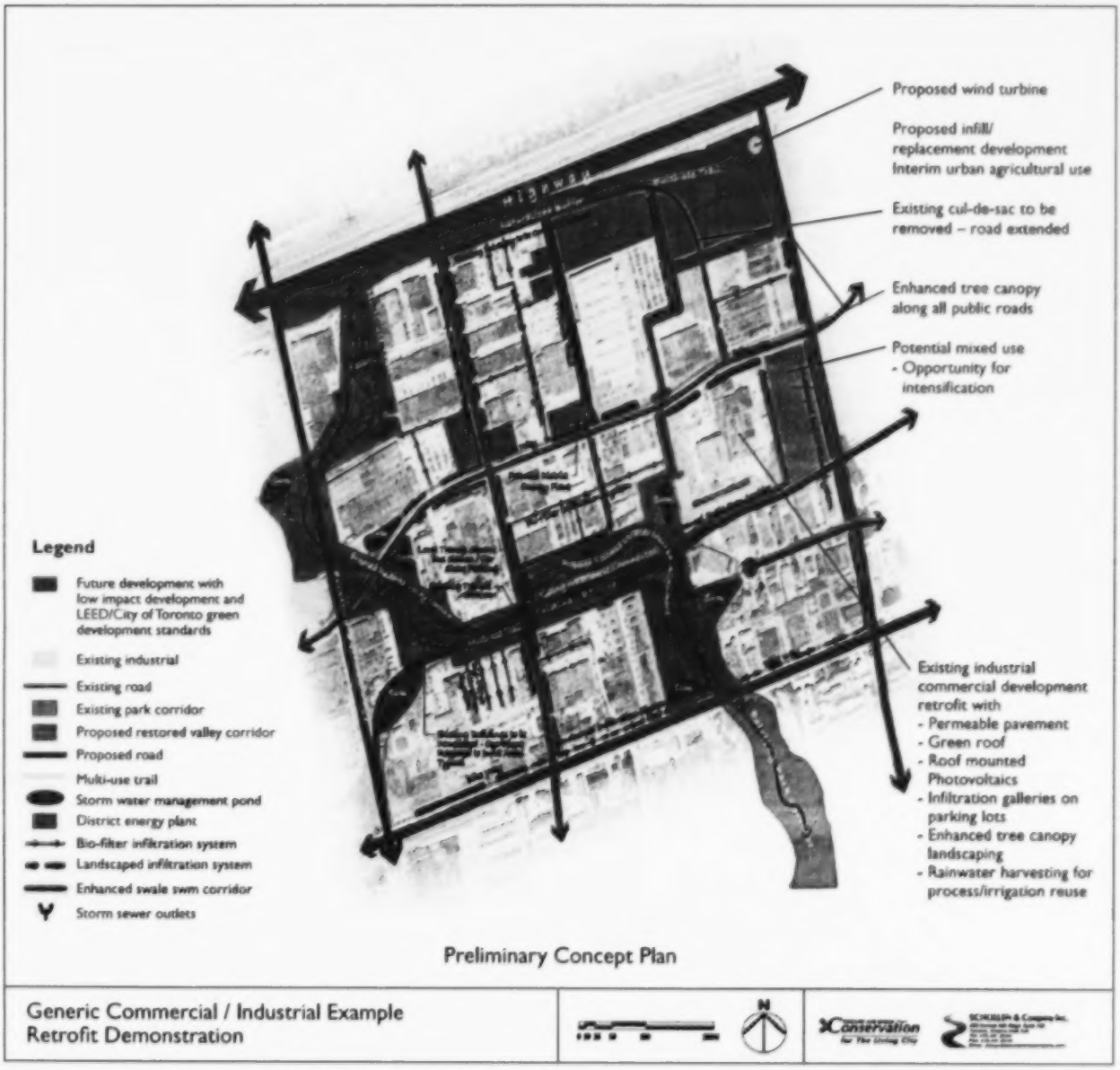

Proposed wind turbine
Proposed infill/ replacement development Interim urban agricultural use
Existing cul-de-sac to be removed – road extended
Enhanced tree canopy along all public roads
Potential mixed use - Opportunity for intensification
Existing industrial commercial development retrofit with
- Permeable pavement
- Green roof
- Roof mounted Photovoltaics
- Infiltration galleries on parking lots
- Enhanced tree canopy landscaping
- Rainwater harvesting for process/irrigation reuse
Legend
Future development with low impact development and LEED/City of Toronto green development standards
Existing industrial
Existing road
Existing park corridor
Proposed restored valley corridor
Proposed road
Multi-use trail
Storm water management pond
District energy plant
Bio-filter infiltration system
Landscaped infiltration system
Enhanced swale swm corridor
Storm sewer outlets
Preliminary Concept Plan
Generic Commercial / Industrial Example Retrofit Demonstration
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Figure 5 Generic Commercial/Industrial Concept Plan

Concept Site Features

The generic commercial / industrial site is representative of many sites throughout the watershed built prior to the establishment of current standards for sustainability. Many of these aging sites are due for redevelopment, presenting an excellent opportunity to work with private sector and municipal partners to give these sites a sustainability makeover. TRCA will continue to search for a suitable demonstration site to implement the concept site plan in partnership with local business groups and the municipality.

The concept plan is focused on rebuilding/retrofitting the study area to restore water balance, mitigate flooding, improve water quality and enhance overall environmental sustainability. The plan addresses the needs of a generic industrial park, typical of many across the watershed, that were built in the 1960s without consideration of modern stormwater management or energy efficiency standards. Many of these areas are currently in transition, with facilities being upgraded and retrofitted to meet modern business requirements. The remaking of an aged, inefficient industrial area will demonstrate the feasibility and benefits of both modest retrofits and bold planning moves in achieving water balance and environmental sustainability objectives.

Modelling Results

This site showed the greatest potential reduction in peak flow rates (ranges from 30% for a 100 year storm event to 80% for a 5 mm storm) and total runoff volumes (20-85% reductions) of all the concept sites under the 'proposed conditions'. Much of the site is currently blanketed by hard and impervious surfaces—roadways, roofs, parking lots and storage areas. The modelling results suggest significant benefits that can result from retrofitting existing industrial developments with source control projects.

A water budget analysis evaluated the impact of the conceptual source control measures on stormwater runoff volumes and potable water usage. City of Toronto design criteria were used to estimate average annual potable water use and calculate an estimated reduction based on the rainwater harvesting proposals in the concept plan. The modelling predicted a 30% reduction in potable water use if the rainwater harvesting assumptions are implemented. This reduction in water use also saves energy costs associated with pumping and treating water.

Existing: Typical of many low rise industrial areas across the watershed, hard and impermeable surfaces predominate which encourages rapid runoff and potential flooding. The tree canopy is largely absent, the streetscape bleak, and there are few alternatives to truck and car transport.

Prospective: Trees and low maintenance native vegetation have been planted along the right-of-way, while a public transit route and bike lanes are added. Solar panels have been installed on the large flat roof of the closest facility. Where feasible, parking lots and driveways are retrofitted with semi-permeable surfaces.

Figure 6 Transforming an Industrial Enclave

CONCLUSIONS

The implementation of low impact development measures in existing areas has a significant impact on the reduction of both peak stormwater release rates and runoff volumes. However, it should be noted that the types of low impact development measures that can be implemented for a subject location depend highly on the existing site conditions and constraints and the type of land use. As a result, it is difficult to generalize the effects of the measures as they will be different on a site by site basis.

IMPLICATIONS FOR THE HOUSING INDUSTRY

The results of the modelling indicate that implementation of innovative stormwater control practices and low impact development strategies can result in more resilient stormwater management systems and, by extension, better protection of watersheds and surface water quality. The stormwater modelling of the watershed revitalization scenarios provided a quantitative estimate of potential impacts associated with the stormwater control measures. This information can help to support the development of business cases for implementing such practices at the sites studied and similar locations throughout the watershed. The research project provides useful examples of innovative stormwater measures for those considering similar measures elsewhere.

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Housing Research at CMHC

Under Part IX of the ***National Housing Act***, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

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